



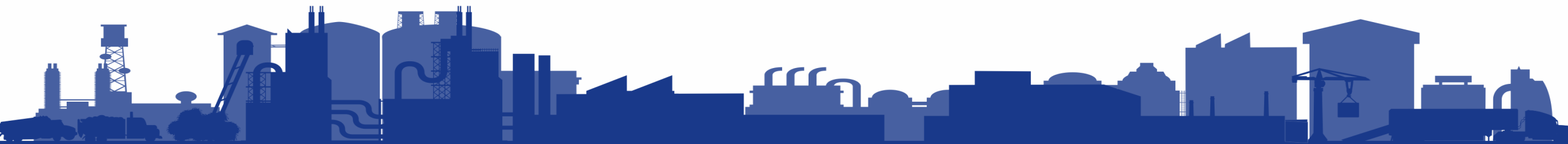
VIRTUAL PROCESS HEATING INPLT

Session 3



Training Module # 3

MEASUR Software Tools for Process Heating



MEASUR – Process Heating Module

The screenshot displays the MEASUR web application interface. On the left is a sidebar with the U.S. Department of Energy logo and navigation links. The main content area features the MEASUR logo and a welcome message. Below this, two large curved arrows point to two main sections: 'Create Assessment' and 'Properties & Equipment Calculators'. The 'Create Assessment' section lists six options: Create Pump Assessment, Create Process Heating Assessment, Create Fan Assessment, Create Steam Assessment, and Create Treasure Hunt. The 'Properties & Equipment Calculators' section lists seven categories: Motors, Pumps, Fans, Process Heating, Steam, Compressed Air, Lighting, and General. At the bottom of the main area is a link to 'View All Your Assessments'.

MEASUR

Welcome to the most efficient way to manage and optimize your plant's systems and equipment.

Create an assessment to model your system and find opportunities for efficiency or run calculations from one of our many property and equipment calculators. Get started with one of the following options.

Create Assessment
Model a system and explore multiple optimization scenarios.

- Create Pump Assessment**
formerly DOE Pumping System Assessment Tool (PSAT)
- Create Process Heating Assessment**
formerly DOE Process Heating Assessment and Survey Tool (PHAST)
- Create Fan Assessment**
formerly DOE Fan System Assessment Tool (FSAT)
- Create Steam Assessment**
formerly DOE Steam System Modeler Tool (SSMT)
- Create Treasure Hunt**
Energy efficiency calculators for facilitating a Treasure Hunt

Properties & Equipment Calculators
Generate detailed properties and test a variety of adjustments.

- Motors
- Pumps
- Fans
- Process Heating
- Steam
- Compressed Air
- Lighting
- General

[View All Your Assessments](#)

U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy

Home

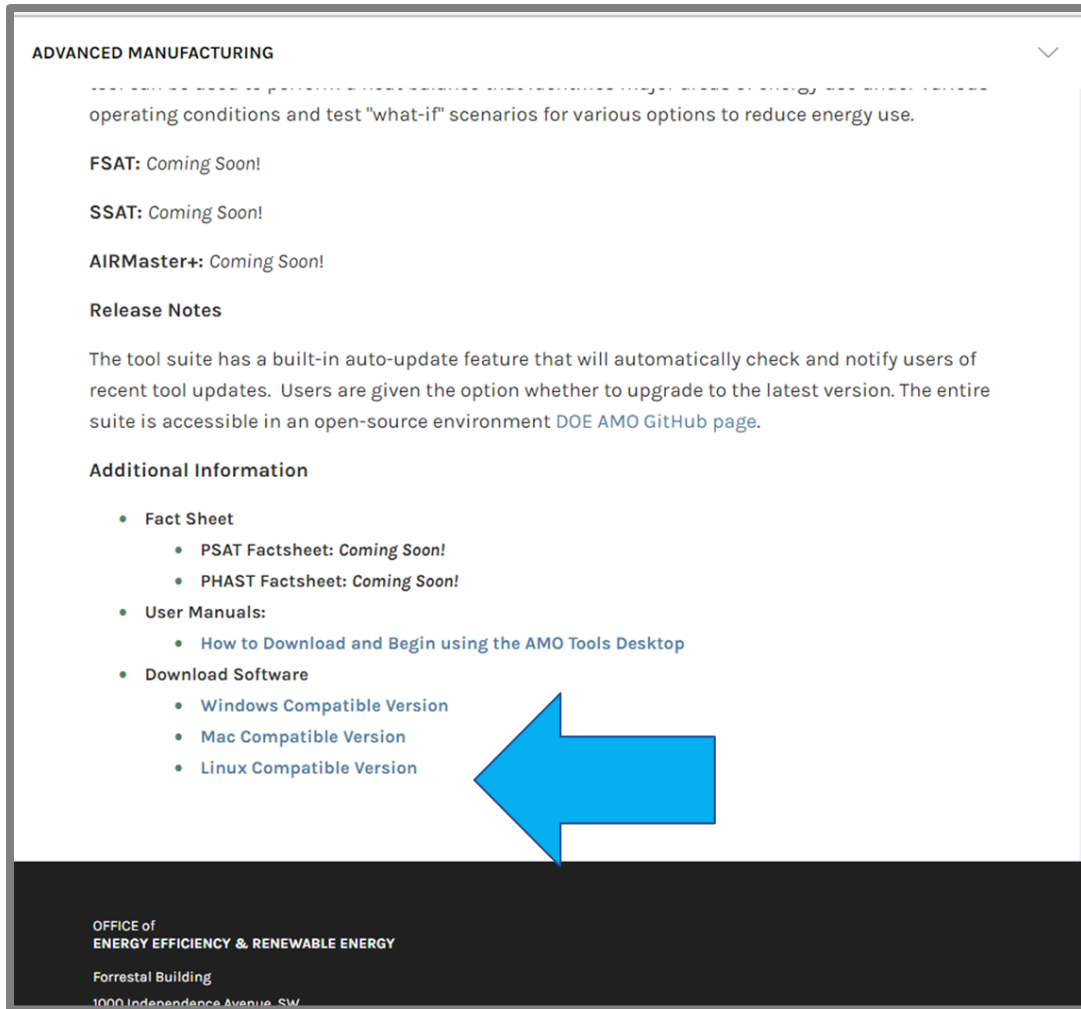
- All Assessments
 - New Assessment
 - Boiler
 - ArcelorMittal
 - Baking Oven
 - ArcelorMittal Warren OH
- Examples
 - Reheat Furnace Case Study
 - Example Pump
 - Fan Example

All Calculators

- Motors
- Pumps
- Fans
- Process Heating
- Steam
- Compressed Air
- Lighting
- General

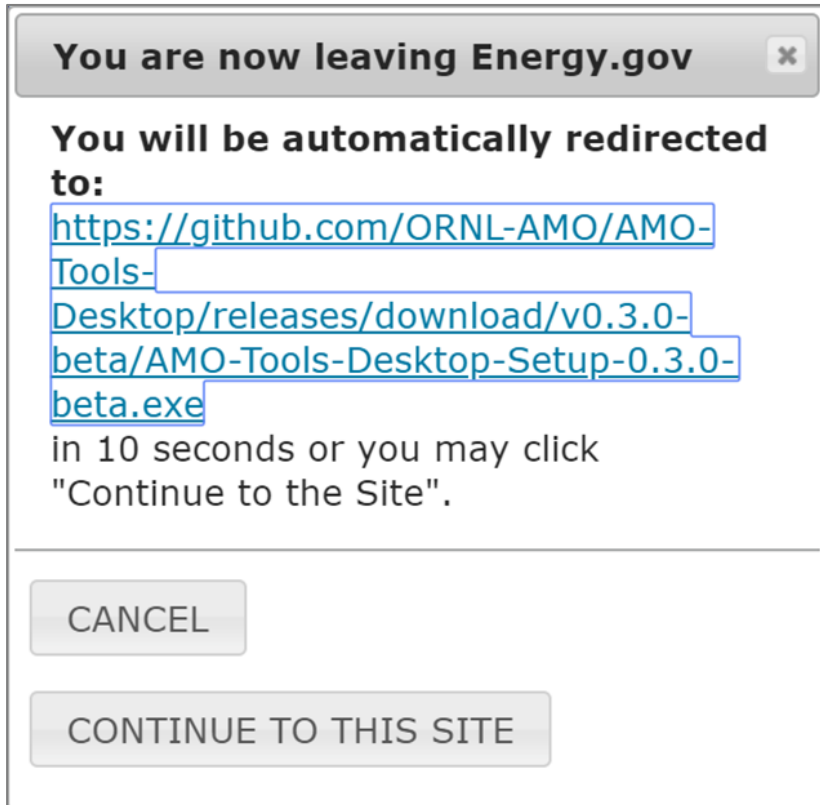
Settings
Custom Materials
Tutorials
About
Feedback
Acknowledgments
v0.5.3-beta

Download via DOE-EERE- AMO website



- <https://www.energy.gov/eere/amo/measur>
- Includes overview of the effort to reprogram our legacy tools
- Scroll to the bottom to find and download your version

Download via DOE-EERE- AMO website

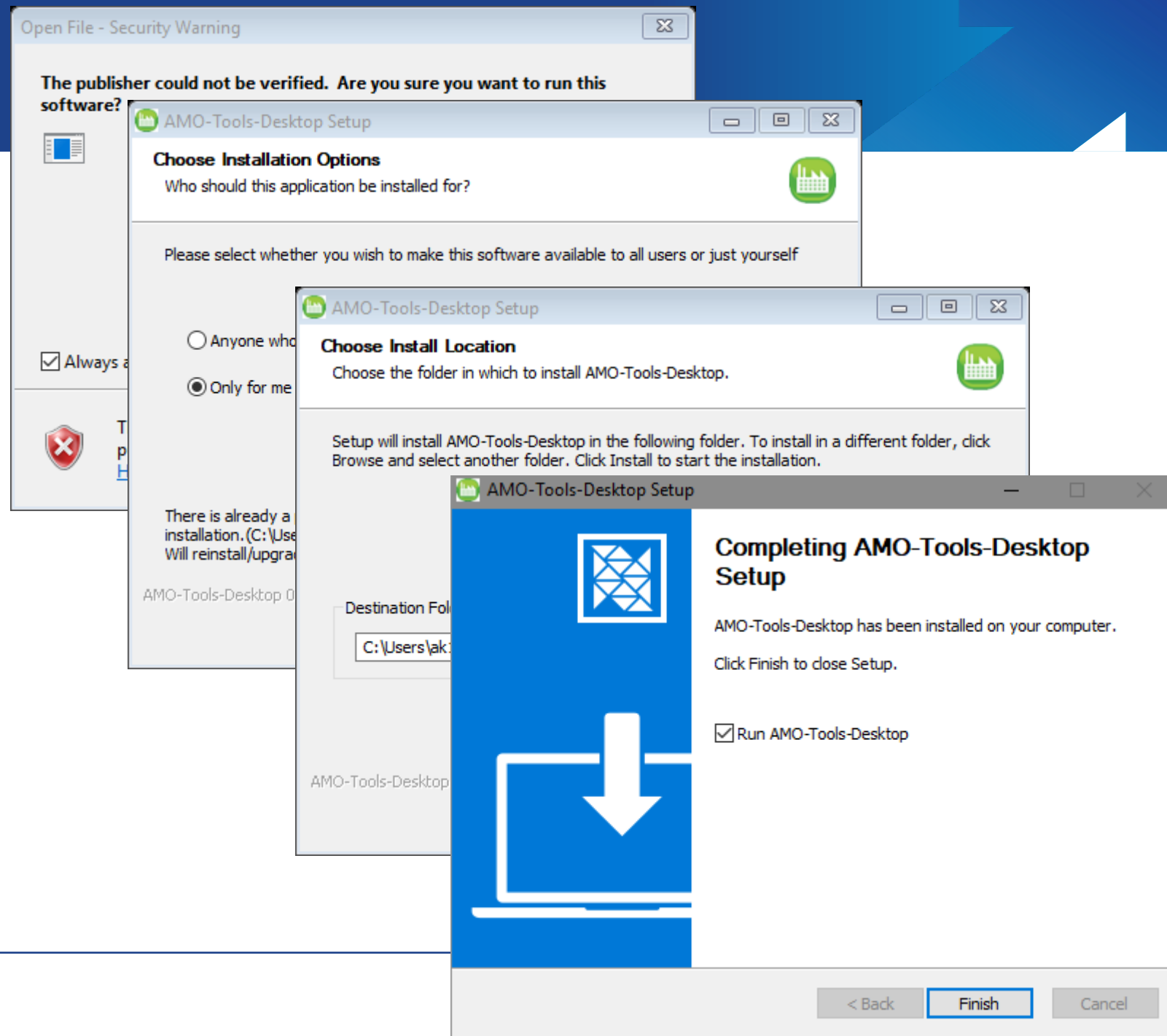


- This message will appear indicating that the file you are downloading is hosted on another website.
- That web site is GitHub, the common repository for software applications and is perfectly safe.



Download

- Click the file extension that matches your operating system
- Open the download
- Click “Run”
- Follow the instructions for the Installation Wizard
- If updating via the webpage DO NOT uninstall first



Updating

- This Tool is in beta, so we are constantly upgrading it and publishing releases fairly often.
- After installation, if an update becomes available, a popup will appear at startup to notify you.
 - You can choose to update right away, or you can wait.
 - If for some reason this does not happen, you can download from the AMO Tools Download Center
- **DO NOT UNINSTALL** before updating, you will lose ALL your assessments.

PHASSTEx (Excel Version)

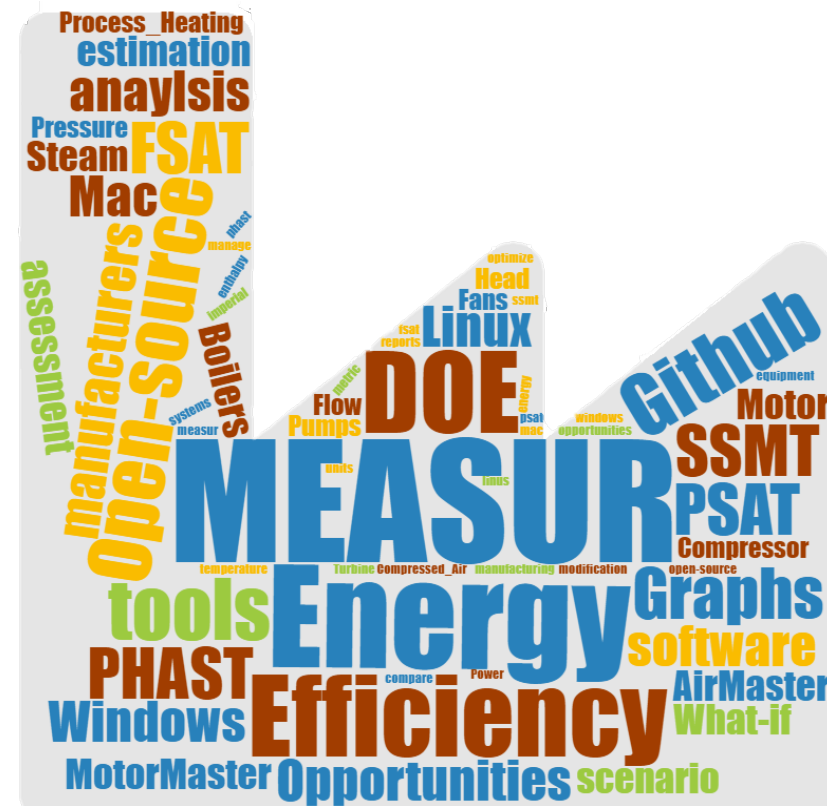
Process Heating Assessment and Survey Tool (Excel Version) (PHASSTEx v1.01)

PHASSTEx - Excel International Version		
Developed by E3M Inc. under contract with Oak Ridge National Laboratory		
What is PHASSTEx?		
Control Page		
PHASSTEx For Excel v1.02.xls		
No.	Items	Number of Components
1	Plant General Information	
2	Furnace Data	
3.1	Charge material- Solids (wet or dry) Enter "0" if none	3
3.2	Charge material- Liquids Enter "0" if none	3
3.3	Charge material- Gases/vapors Enter "0" if none	3
4	Fixtures, trays, conveyor etc. Enter "0" if none	6
5	Wall surface heat losses	10
6	Water or air cooling (internal) Enter "0" if none	6
7	Atmosphere or makeup air Enter "0" if none	3
8	Flue Gases	
9	Radiation losses from openings- Enter "0" if none	6
10	Power use by Electric Motors & Other Devices	10
11	Other heat loss or generation- Enter "0" if none	2
View PHASSTEx Summary Report		
View PHASSTEx Energy Usage Distribution		

[Enter Data](#)[Enter Data](#)[Enter Data](#)[Enter Data](#)[Enter Data](#)[Enter Data](#)[Enter Data](#)[Enter Data](#)[Enter Data](#)[Enter Data](#)[Enter Data](#)[Enter Data](#)[Enter Data](#)[Enter Data](#)[Go To Report](#)[Go To Report](#)[Go To Report](#)[Go To Report](#)

MEASUR Demo

Using MEASUR



Getting Started

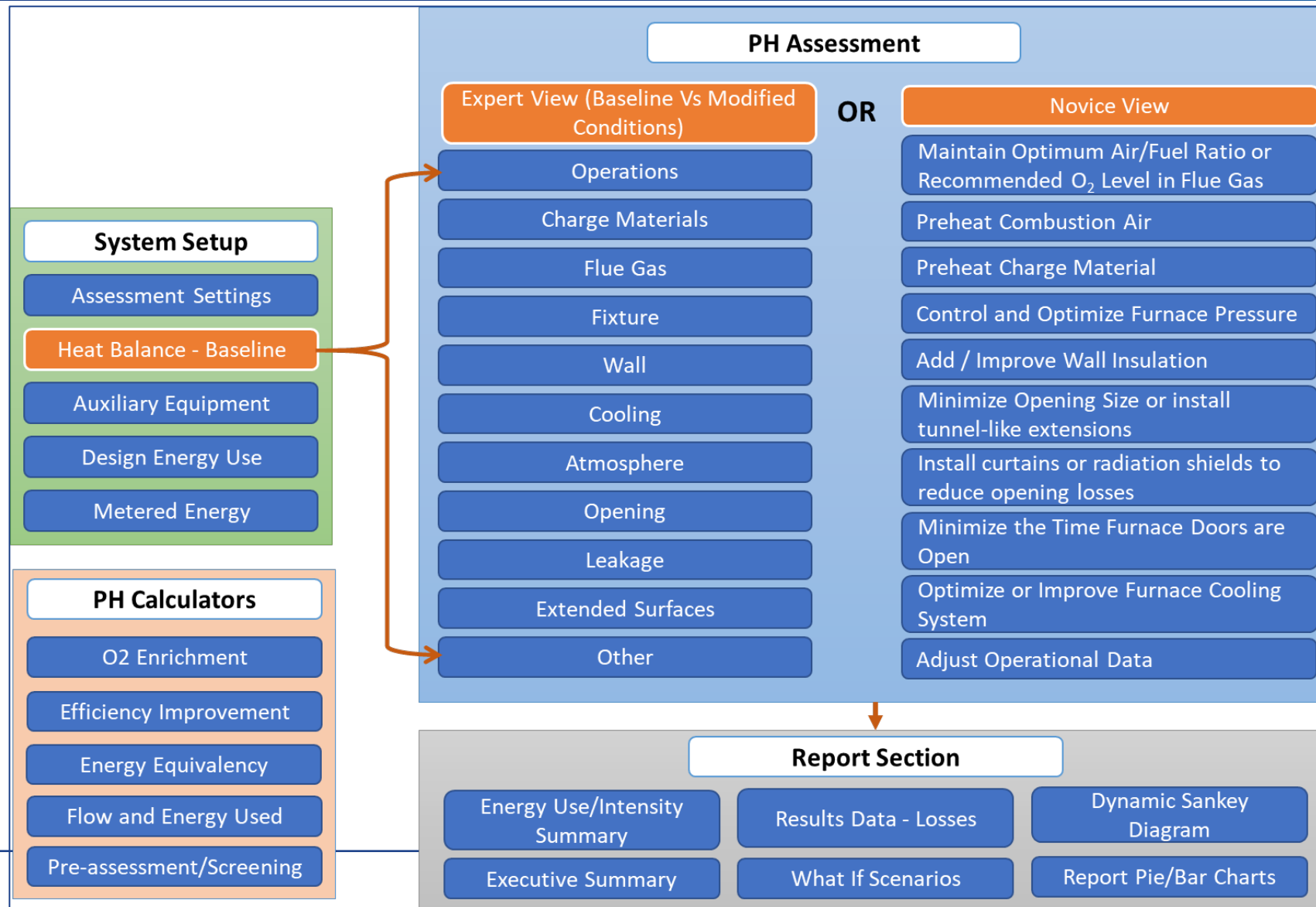
- ➡ Start an assessment
- ➡ Create an inventory
- ➡ View Assessment Dashboard
- ➡ Use Properties & Equipment Calculators
- ➡ Help and User Experience
 - Change Settings
 - View Tutorials
 - Manage Custom Materials
 - Provide Feedback
 - Translate

The screenshot shows the MEASUR web application interface. The header includes the U.S. Department of Energy logo and the MEASUR title. A sidebar on the left contains navigation links: Home, All Assessments, Examples, Plant B, Data Exploration, All Calculators, Motors, Process Cooling, Pumps, Fans, Process Heating, Steam, Compressed Air, Lighting, General, Settings, Custom Materials, Tutorials, About, Feedback, Acknowledgments, Translate, and v0.8.0-beta. The main content area features a 'Create Assessment' section with options like 'Create Pump Assessment', 'Create Process Heating Assessment', 'Create Fan Assessment', 'Create Steam Assessment', and 'Create Treasure Hunt'. To the right, there are sections for 'Properties & Equipment Calculators' and 'Inventory Management'. A red arrow points from the 'Add Assessment' button to the 'Create Assessment' section. A yellow arrow points from the 'All Calculators' link to the 'Properties & Equipment Calculators' section. A green arrow points from the 'Inventory Management' link to the 'Inventory Management' section. A blue arrow points from the 'View All Your Assessments' link to the 'All Assessments' link in the sidebar.

MEASUR Process Heating Assessment Module

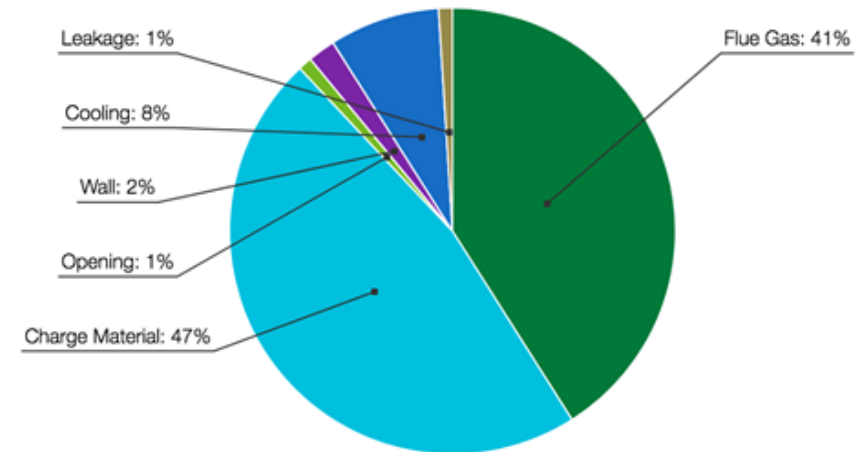
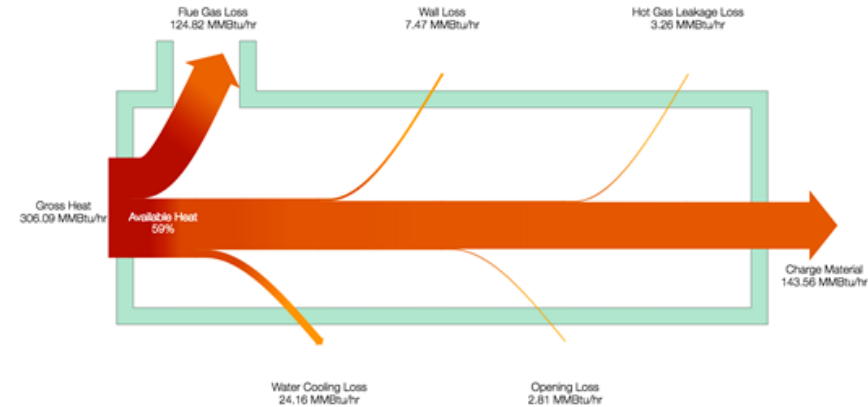
- MEASUR can be used for fuel fired, electric, or steam-based systems as well as hybrid systems
- The user defines the heating system type in the 'Design Energy Use' section
- For all heat system types, the user can select English units or international units of measurements
- Assessments can be shared or transferred using MEASUR's built-in import/export functionality

Overview of the MEASUR PH Assessment Module Capabilities



Process Heating System Assessment Tool

- Models the heat balance for a heating system such as a furnace, oven, boiler, etc.
- The heat balance is based on thermal calculations using simple measurements at several locations on a heating system.
- Allows the user to calculate potential energy savings for the different scenarios
- The results are given in several formats such as pie-charts, static Sankey Diagram, tables, etc.



Energy Modeling using MEASUR



Step 1: Data Collection

Reheat Furnace Case Study

System Setup | Assessment | Design

Explore Opportunities | Modify All Conditions | Export View

Navigation View

SELECT POTENTIAL ADJUSTMENT PROJECTS

Select potential adjustment projects to explore opportunities to increase efficiency and the effectiveness of your system.

[Add New Scenario](#)

Modification Name: Individual Opportunity 4 - Reduce CO level in flue gases

☒ Maintain Optimum Air/Fuel Ratio or Recommended O₂ Level in Flue Gas

Baseline Oxygen Calculation Method	Modified Oxygen Calculation Method
Oxygen in Flue Gas	Oxygen in Flue Gas
Baseline Oxygen in Flue Gas	6 %
Modified Oxygen in Flue Gas	2 %
Baseline excess Air in Flue Gas	36.52 %
Modified Oxygen in Flue Gas	69.90 %

☐ Preheat Combustion Air

☐ Preheat Charge Material

☐ Control and Optimize Furnace Pressure

☐ Add / Improve Wall Insulation

☐ Minimize Opening Size or install tunnel-like extensions

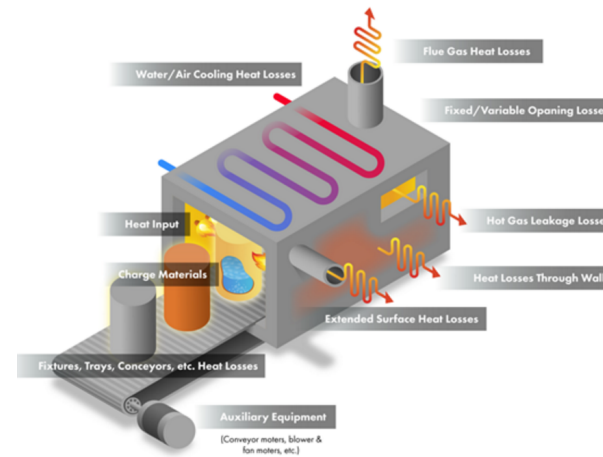
☐ Install curtains or radiation shields to reduce opening losses

☐ Minimize the Time Furnace Doors are Open

☐ Optimize or improve Furnace Cooling System

☐ Adjust Operational Data

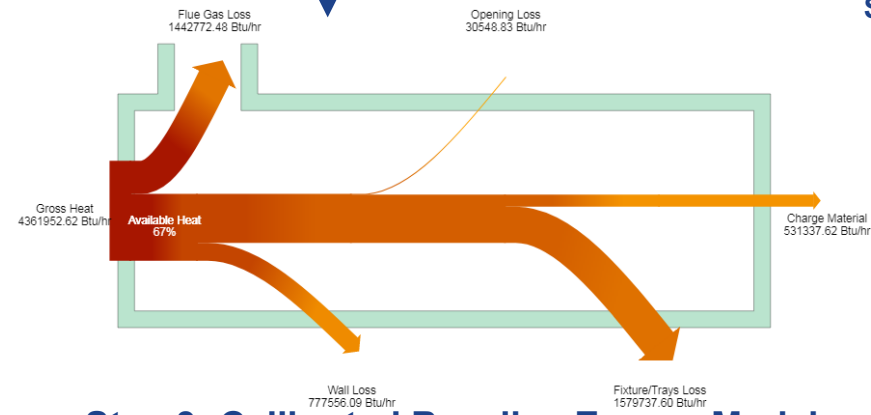
Step 4: "What if" analysis to identify and quantify savings opportunity



Step 2: Determine the Energy Losses from different Components



Sub-Metered or Design data to verify energy model



Step 3: Calibrated Baseline Energy Model

Energy Assessment using MEASUR

PH Demo
Fuel-fired
Last modified: Nov 14, 2019

System Setup **Assessment** Diagram Re

Explore Opportunities Modify All Conditions
Novice View Expert View

SELECT POTENTIAL ADJUSTMENT PROJECTS
Select potential adjustment projects to explore opportunities to increase efficiency and the effectiveness of your system.

Add New Scenario

Modification Name

- ☐ Maintain Optimum Air/Fuel Ratio or Recommended O₂ Level in Flue Gas
- ☐ Preheat Combustion Air
- ☐ Preheat Charge Material
- ☐ Improve Materials Handling
- ☐ Avoid Fixture Cooling
- ☐ Add / Improve Wall Insulation
- ☐ Minimize Opening Size or install tunnel-like extensions
- ☐ Install curtains or radiation shields to reduce opening losses
- ☐ Minimize the Time Furnace Doors are Open
- ☐ Adjust Operational Data

PH Assessment Views

Novice View


- Maintain Optimum Air/Fuel Ratio or O₂ Levels in Flue Gas
- Preheat Combustion Air
- Preheat Charge Material
- Control Furnace Pressure
- Add/Improve Wall Insulation
- Minimize Opening Size or Install Tunnel-like Extensions
- Minimize Furnace Door Opening
- Optimize Furnace Cooling
- Adjust Operational Data

Expert View (Baseline vs. Modified)

- Operations
- Charge Materials
- Flue Gas
- Fixtures
- Walls
- Cooling
- Atmosphere
- Opening
- Leakage
- Extended Surfaces
- Other



- Explore Opportunities: build scenarios from pre-established energy savings measures
- Modify All Conditions: build scenarios using same form as baseline

e.g. Reheat Furnace Assessment—Expert View with notes



Reheat Furnace AISTech
Fuel-fired
Last modified: Feb 28, 2020

System Setup **Assessment** Diagram Report Sankey Calculators



Explore Opportunities
Novice View

Modify All Conditions
Expert View

Repair wall insulation
Selected Scenario

View / Add Scenarios

Operations ● Charge Materials ① Flue Gas ① Fixture **Wall ①** Cooling ① Atmosphere Opening ② Leakage Extended Surface Other

BASELINE

▲ Loss #1

Average Surface Temperature175°F

Ambient Temperature70°F

Wind Velocity0mph

Surface Shape / OrientationVertical plates

Add New Surface

Surface Shape / Orientation Factor1.394

Surface Emissivity0.9

Total Outside Surface Area11100ft²

Correction Factor1

Loss #1 Total2.67494 MMBtu/hr

Wall Loss Total2.67494 MMBtu/hr

REPAIR WALL INSULATION

▲ Loss #1

Average Surface Temperature150°F

Ambient Temperature70°F

Wind Velocity0mph

Surface Shape / OrientationVertical plates

Add New Surface

Surface Shape / Orientation Factor1.394

Surface Emissivity0.9

Total Outside Surface Area11100ft²

Correction Factor1

Loss #1 Total1.91731 MMBtu/hr

Wall Loss Total1.91731 MMBtu/hr

RESULTS**HELP****NOTES**

* Repair insulation and remove hot spots

Back

NextView Report




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ENERGY

e.g. Reheat Furnace Assessment—Novice View with results



Reheat Furnace AISTech
Fuel-fired
Last modified: Feb 28, 2020

System Setup **Assessment** Diagram Report Sankey Calculators



Explore Opportunities
Novice View

Modify All Conditions
Expert View

Warm charging of slabs
Selected Scenario

View / Add Scenarios

SELECT POTENTIAL ADJUSTMENT PROJECTS
Select potential adjustment projects to explore opportunities to increase efficiency and the effectiveness of your system.

Add New Scenario

Modification Name

Warm charging of slabs

☐ Maintain Optimum Air/Fuel Ratio or Recommended O₂ Level in Flue Gas

☐ Preheat Combustion Air

☒ Preheat Charge Material

☒ Modify Initial Temperature

Material #1

Baseline Initial Temperature

60

°F

Modification Initial Temperature

250

°F

☐ Add / Improve Wall Insulation

☐ Minimize Opening Size or install tunnel-like extensions

☐ Install curtains or radiation shields to reduce opening losses

☐ Minimize the Time Furnace Doors are Open

☐ Optimize or Improve Furnace Cooling System

☐ Adjust Operational Data

Back

RESULTS

HELP

NOTES

Energy Loss/Use	Baseline MMBtu/hr	Warm charging of slabs MMBtu/hr
Charge Materials	143.36	131.20
Fixtures, trays etc.	—	—
Wall Losses	2.67	2.67
Cooling Losses	24.06	24.06
Atmosphere Losses	—	—
Opening Losses	3.41	3.41
Leakage Losses	—	—
Extended Surface Losses	—	—
Other Losses	—	—
Total Net Heat Required	173.51	161.35
Available Heat (%)	62.1%	62.1%
Flue Gas Losses	106.00	98.57
Exothermic Heat from Process	-0.90	-0.90
Gross Heat Input	278.61	259.02

View Report



Reheat Furnace Results—Executive Summary



Reheat Furnace AISTech

Fuel-fired

Last Modified Feb 28, 2020, 12:40:23 PM

Print

Export to CSV

Energy Used

Executive Summary







Result Data

Report Graphs

Sankey

Input Summary

Facility Info

	Baseline	Warm charging of slabs	Improved cooling insulation	Repair wall insulation	Monitor air/fuel ratio	Preheat combustion air	Extend preheat zone	Combined Opportunities
Percent Savings (%)	—	 7.0%	 3.0%	—	 3.0%	 2.0%	 8.0%	 21.0%
Energy Intensity (Btu/lb)	696.53	647.56	674.17	693.48	675.74	682.49	638.15	548.51
Annual Energy Used (MMBtu/yr)	1,925,800	1,790,400	1,863,900	1,917,300	1,868,300	1,886,900	1,764,300	1,516,500
Annual Energy Savings (MMBtu/yr)	—	135,400	61,832	8,435.9	57,483	38,828	161,420	409,240
Annual Cost	\$8,107,465	\$7,537,443	\$7,847,153	\$8,071,949	\$7,865,460	\$7,943,998	\$7,427,904	\$6,384,549
Annual Cost Savings	—	\$570,022	\$260,312	\$35,515	\$242,004	\$163,467	\$679,560	\$1,722,915
Implementation Costs	—	—	—	—	—	—	—	—
Simple Payback Period (months)	—	—	—	—	—	—	—	—

Modification Notes

Warm charging of slabs — Charge Materials: * Hot/warm charging of slabs * Charge end vestibule addition to extend furnace heating length * Increase hearth coverage

Improved cooling insulation — Cooling Losses: * Low conductivity skid insulation


Repair wall insulation — Wall Losses: * Repair insulation and remove hot spots

Monitor air/fuel ratio — Flue Gas Losses: * Atmosphere monitoring/control of zone air/fuel ratio * Trip O2 level to 2%.

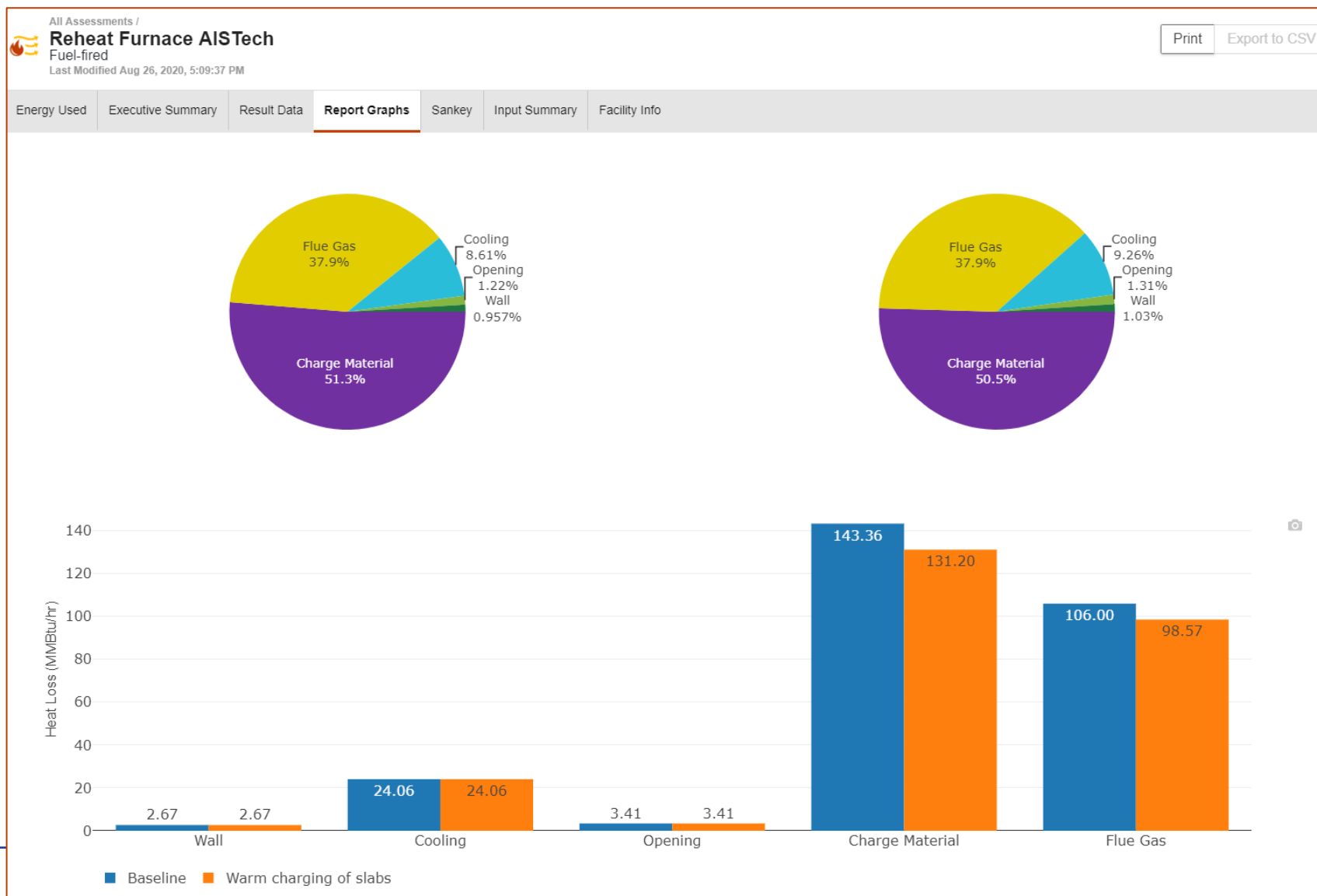
Preheat combustion air — Flue Gas Losses: * Increase combustion air preheat temperature (850 degree F to 900 degree F.)

Extend preheat zone — Flue Gas Losses: ** Please note – furnace flue gas temperature drops from 1800 degree F to 1600 degree F due to extended furnace heating length for preheating the charge material.

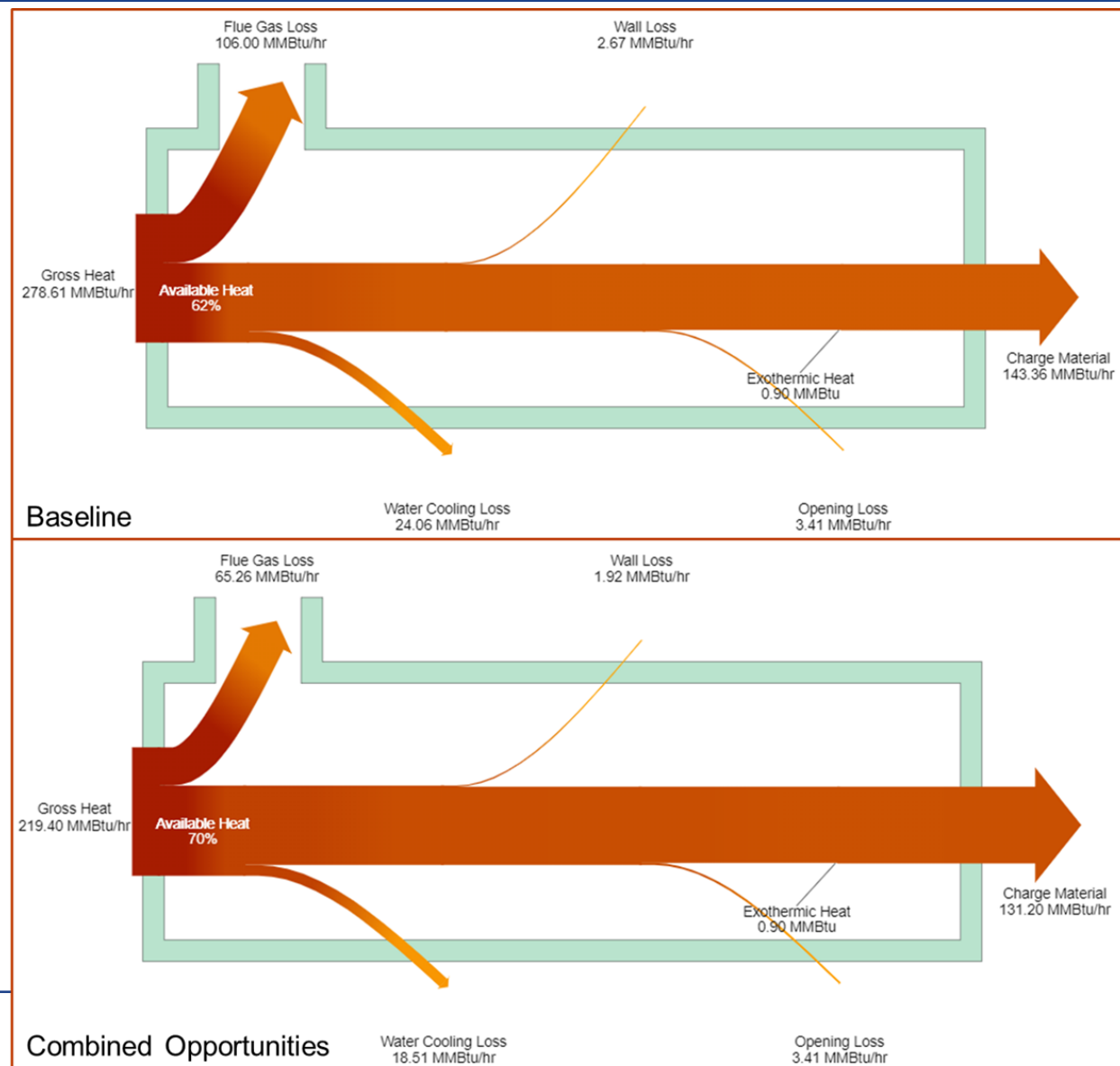
Reheat Furnace Results Data

<div>  Reheat Furnace AISTech Fuel-fired Last Modified Feb 28, 2020, 12:40:23 PM </div> <div> Print Export to CSV </div>								
Energy Used	Executive Summary	Result Data	Report Graphs	Sankey	Input Summary	Facility Info		
Energy Loss/Use	Baseline MMBtu/hr	Warm charging of slabs MMBtu/hr	Improved cooling insulation MMBtu/hr	Repair wall insulation MMBtu/hr	Monitor air/fuel ratio MMBtu/hr	Preheat combustion air MMBtu/hr	Extend preheat zone MMBtu/hr	Combined Opportunities MMBtu/hr
Charge Materials	143.36	131.20	143.36	143.36	143.36	143.36	143.36	131.20
Fixtures, trays etc.	---	---	---	---	---	---	---	---
Wall Losses	2.67	2.67	2.67	1.92	2.67	2.67	2.67	1.92
Cooling Losses	24.06	24.06	18.51	24.06	24.06	24.06	24.06	18.51
Atmosphere Losses	---	---	---	---	---	---	---	---
Opening Losses	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41
Leakage Losses	---	---	---	---	---	---	---	---
Extended Surface Losses	---	---	---	---	---	---	---	---
Other Losses	---	---	---	---	---	---	---	---
Total Net Heat Required	173.51	161.35	167.96	172.75	173.51	173.51	173.51	155.04
Available Heat (%)	62.1%	62.1%	62.1%	62.1%	64.0%	63.3%	67.7%	70.4%
Flue Gas Losses	106.00	98.57	102.61	105.54	97.68	100.38	82.65	65.26
Exothermic Heat from Process	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90
Gross Heat Input	278.61	259.02	269.67	277.39	270.30	272.99	255.26	219.40

Reheat Furnace Results—Executive Summary



Reheat Furnace Results—Sankey diagrams



Measurements and Diagnostic Equipment

- Combustion Measurement
 - Combustion Analyzer
 - Combustion Efficiency
 - O₂, CO, CO₂
 - Inlet Temperature, Flue, Temperature, Draft, Excess Air
- Surface Heat Loss
 - Temperature



Technical Assistance: Diagnostic Equipment Program

Field data is best for evaluating system performance



- Free of charge, including shipping
- Use equipment for one day, or up to four weeks
- Some technical assistance with selection and usage
- First come, first serve application

Website link - [The Diagnostic Equipment Program](#)



MEASUR Process Heating Assessment Demonstration

Acknowledgements

Process Heating and Steam System Subject Matter Experts

- Arvind Thekdi, E3M, Inc.
 - Developed the previous versions of PHAST and contributed algorithms to the newer version of PHAST
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 - Developed the previous versions of DOE steam tools and continued to contribute to MEASUR by providing feedback
- Glenn Cunningham, Tennessee Technical University
 - Reviewed and provided feedback for the Pump, Fan, and Steam modules, as well as many calculators
- Riyaz Papar, Hudson Tech
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Questions?

